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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Vol. 44 No. 12

BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1917

The development of the embryo-sac and of the embryo in Phaseolus vulgaris

MABEL MARY BROWN

(WITH PLATES 25 and 26)

INTRODUCTION

So far as I have been able to find, the only previously published description of the embryo-sac or embryo of *Phaseolus* is by Guignard (1881), who studied forty species of Leguminosae, among them *Phaseolus multiflorus*. In this species he found that an axial row of but three macrospores is formed. The innermost cell of this row by three successive nuclear divisions forms the embryo-sac, which is typical in every respect; the antipodals are ephemeral. The first division of the egg is transverse, and occurs at the same time that the primary endosperm nucleus divides. A pro-embryo of three cells is formed, the terminal one of which develops into the embryo; the other cells form the suspensor. Divisions follow until an embryo is formed at the apex of a filamentous suspensor, which is two cells in thickness and whose basal cells are conspicuously swollen.

In the present study buds, pistils, and developing fruits were obtained from the following varieties of *Phaseolus vulgaris:* "David Kidney," "Longfellow," "Pole," and "Kidney Wax," plants of which were grown in the greenhouse during the fall and winter of 1914–15 and 1915–16, and "Wardwell's Wax," grown in the

[The BULLETIN for November (44: 501–534. *pl.* 24) was issued November 20, 1917]

garden during the summer of 1915. Material was collected from the time the buds began to appear until the fruits were fully grown.

The very young buds were placed in the fixing fluids intact; the floral envelopes were removed from the larger buds and flowers to insure penetration of the fixing fluids. For the same reason the pods were cut into pieces, and in the case of the older pods the young seeds were picked out and placed separately in the fixing solutions. Flemming's solutions, medium and strong; 1 per cent. chrom-acetic acid, Juel's fluid and Carnoy's fluid were used as fixatives. The best preparations showing the development of the macrospores and the embryo-sac were obtained from material fixed in Flemming's medium solution and in chrom-acetic acid. Juel's and Carnoy's fluids gave best results in the fixation of embryos.

Longitudinal sections of these various structures were cut from five to twelve microns in thickness. Flemming's triple stain, Heidenhain's iron-alum haematoxylin, and a combination of the latter with Lichtgrün were used.

I have found no differences between any of the varieties used, so far as the history of the embryo-sac and the embryo are concerned; the description which follows applies equally, therefore, to all the varieties named.

THE MACROSPORES AND THE EMBRYO-SAC

In the varieties of *Phaseolus vulgaris* studied, from two to seven ovules are borne in an apparently single row upon the adherent edges of the carpel. When first formed the ovules are orthotropous, but as growth proceeds they become recurved and are campylotropous when mature.

The two integuments, when fully grown, surround the ovule on all sides, but are slightly shorter on the side toward the placenta. They grow rapidly and by the time that the macrospore mother cell is fully grown the outer integument has reached almost to the apex of the ovule, the inner one being at this time about two thirds the length of the outer integument.

A hypodermal cell in the axial row of the nucellus becomes larger than the surrounding cells and stands out conspicuously

among them (PLATE 25, FIG. 1). This cell is typically five-sided in section; it contains a very large nucleus and stains more deeply than the adjacent cells. At a later stage the young macrospore mother cell is separated from the epidermal layer by another layer of cells (FIG. 4). Still later, when the macrospore mother cell is fully grown, there are often two layers of cells between it and the epidermis (FIG. 5); this is not always the case, however, for not infrequently the elongated macrospore mother cell is in the third instead of the fourth layer of cells. No division figures were seen either in the first differentiated hypodermal cell or in the cells of the epidermal layer. For this reason, I have been unable to determine whether the hypodermal cell that is early distinguished by its size itself functions as the macrospore mother cell, or whether, on the other hand, this hypodermal cell divides, one of its daughter cells becoming the macrospore mother cell. On the whole, the arrangement of the subepidermal layers at the later stages (FIG. 5) supports rather more strongly the former hypothesis. Preparations were obtained in which there were what seemed to be two young macrospore mother cells in an axial row (FIG. 3); another preparation showed two young mother cells lying side by side, and in one case two fully grown mother cells lay side by side. In no case, however, was the further development of more than one macrospore mother cell observed.

The fully grown macrospore mother cell is about three times as long as wide (FIG. 6); its nucleus is near the micropylar end of the cell; the chalazal end is usually pointed (FIG. 6), but in some cases quite rounded (FIG. 7). The nucleus remains in the micropylar end of the cell during the prophases of the ensuing division. FIG. 7 shows the nucleus in synapsis. One preparation was obtained showing the heterotypic division; the spindle lies approximately in the center of the cell (FIG. 8). One of the two daughter cells formed by this division fails to undergo a second division, since, so far as my preparations show, a row of but three macrospores is formed (FIG. 9). Guignard (1881) reported the formation of but three macrospores in *Phaseolus multiflorus* but did not determine which of the two daughter cells, formed from the division of the mother cell, fails to divide; he also found a case in which a longitudinal division took place in one of the functionless macrospores;

the innermost macrospore at the chalazal end develops into the embryo-sac, and I find the same thing true in *Phaseolus vulgaris*. In other Leguminosae, according to Guignard, two, three, or four macrospores may be formed and either the innermost spore or the one next it may develop into the embryo-sac. Saxton (1907) finds in *Cassia tomentosa* a deeply buried macrospore mother cell whose division forms a row of four macrospores, of which the one next to the innermost produces the embryo-sac. However, according to Martin (1914), in *Medicago sativa*, *Vicia americana*, and several species of *Trifolium* examined by him, an axial row of four macrospores is formed.

The functional macrospore becomes several times as long as wide before its nucleus divides (PLATE 26, FIG. 11). The two outer macrospores degenerate rapidly, and by the time that the developing macrospore reaches the binucleate stage they have usually disappeared entirely.

After the first nuclear division in the functional macrospore, the two daughter nuclei pass to the respective ends of the sac (FIG. 12), and a large vacuole appears between them. After the second nuclear division each end of the developing macrospore contains a pair of nuclei (FIG. 13). The nuclei at the micropylar end usually remain close together, those at the chalazal end being further apart. After the third division, a group of four nuclei is seen at each end of the embryo-sac.

The polar nuclei begin their migration very soon after the completion of the last nuclear division. Cell division ensues, resulting in the formation of a typical seven-celled embryo-sac (FIG. 14). The egg apparatus presents the usual appearance; the polar nuclei lie a short distance away from the egg apparatus in the median line; at the stage shown in FIG. 14 they have not yet begun to fuse. The antipodal cells are typically triangular in section, and their nuclei are smaller than the other nuclei of the sac. A large vacuole is characteristic of the embryo-sac at this stage, lying between the polar nuclei and the antipodal cells. This development seems to agree, except in minor details, with that of other Leguminosae that have been investigated. Saxton (1907) found an absorptive tissue derived from the antipodal cells in *Cassia tomentosa;* Hofmeister (1858) failed to find antipodal cells in the members

of the family studied by him; Hegelmaier (1880), also, did not see the antipodal cells and seems to have confused endosperm cells with the egg apparatus; according to Guignard (1881) the antipodal cells of *Phaseolus multiflorus* are ephemeral; and Strasburger (1880) found that the same is true of the antipodal cells of four species of *Lupinus*.

The egg grows after its formation (PLATE 25, FIG. 10) and becomes long and broad at the base so that it projects into the embryo-sac beyond the synergids (PLATE 26, FIG. 15). The egg nucleus becomes larger and a large vacuole appears in the cytoplasm toward the micropylar end of the egg. The synergids develop a distinct filiform apparatus (FIG. 15) whose striations arise from the neighborhood of a vacuole at the broader end of each synergid. Martin (1914) described a filiform apparatus in *Trifolium pratense*, but with more conspicuous striations than those which I have observed in *Phaseolus vulgaris*. The synergids change from a pear-shaped to a more narrow tapering form. After fertilization the synergids disintegrate and entirely disappear.

The polar nuclei come to lie close together just below the egg (FIG. 14) and remain in this position for some time. Before fertilization, however, they come into close contact with each other and begin to fuse (FIG. 16), but it is quite possible that their fusion may not be completed before the male nuclei enter the sac and one of the latter fuses with the polar nuclei.

In one preparation a pollen tube was seen entering the embryo-sac. It grows through the micropyle and pushes into the embryo-sac between the cells which form a sheath around the micropylar end of the sac.

The nucellus is gradually absorbed during the development of the embryo-sac, and when the latter is mature the nucellar tissue entirely disappears from the micropylar end and from the sides, leaving these parts of the sac in immediate contact with the inner integument; at the chalazal end of the sac, however, the nucellar tissue persists, its cells grow larger and become arranged in quite definite rows which seem to diverge from the point where the integuments arise from the nucellus. This tissue persists until, late in the history of the embryo-sac, it is finally absorbed. According to Hegelmaier (1880), the nucellus in the ovule of *Lupinus*

is entirely absorbed after fertilization; Ward (1881) notes the deliquescence of the cells surrounding the embryo-sac of *Lupinus venustus;* and Martin (1914) made similar observations on *Medicago sativa*, *Vicia americana*, and several species of *Lupinus.*

THE EMBRYO

The first division of the fertilized egg is transverse (FIG. 18); the basal one of the two cells so formed typically encloses a large vacuole. The next division occurs in this basal cell and is transverse (FIG. 19), so that a filamentous pro-embryo of three cells is invariably formed (FIG. 20). The third division is a longitudinal one (FIG. 21), in the terminal cell; it is quickly followed by longitudinal divisions in the other two cells of the pro-embryo, which are to give rise to the suspensor (FIG. 22). Divisions may now occur in the longitudinal plane perpendicular to that just described, or the divisions in the second longitudinal plane may be preceded by several transverse divisions. The embryo then consists of four rows of seven or eight cells each (FIG. 23); and the basal cells have begun to show evidences of swelling.

Division now ceases except in the cells at the distal end of the embryo. Anticlinal walls are put in (FIG. 24, *a*) in the cells of the terminal tier. Periclinal walls are next formed, cutting off an outer layer of cells, the dermatogen (FIG. 26). In *Medicago sativa*, *Vicia americana*, and several species of *Trifolium*, Martin (1914) observed that the dermatogen is cut off later than the octant stage; Guignard (1881) also found this true in his work on *Phaseolus multiflorus.* When the embryo is about six or seven cells in length (FIG. 24), the four basal cells of the suspensor become swollen and turgid and much elongated; later the next tier of four cells above them also undergo like changes (FIG. 25). The swollen cells at the base of the suspensor continue to grow in length and retain their inflated appearance until late in the history of the embryo; but when the embryo has grown so as almost to fill the cavity of the sac, its growth seems to cause a compression of the basal cells and they become flattened in the micropylar end of the embryo-sac (FIG. 27). Swollen suspensor cells occur in other members of the Leguminosae; Hegelmaier (1880) reported such cells in the embryo of *Lupinus*, but in this case the cells were

multinucleate; Strasburger (1880) observed swollen suspensor cells in *Lupinus*, which in some instances show a tendency to separate from one another. Guignard (1881) also reported the occurrence of inflated cells which are multinucleate in *Orobus aureus*, *O. angustifolius*, and *Pisum sativum*, and suspensor cells which become separated from one another in *Lupinus polyphyllus*. Martin (1914) observed instances in his studies in which the suspensor cells retained their normal appearance and also cases in which the modifications which were noted by other investigators occurred.

At the time of the differentiation of the dermatogen, the embryo proper is almost ovoid in shape (FIG. 26); it retains this form as it increases in size until the appearance of the cotyledons. Cotyledon development begins later than the stage shown in Figure 26; but none of my preparations show satisfactorily the first stages in this development because the plane of the union of the cotyledons is parallel to the flat side of the ovule, and the embryo lies curved in the micropylar end of the embryo-sac. The embryo continues to grow at the expense of the endosperm and of the cushion of nucellar tissue at the chalazal end of the embryo-sac. The nucellus is absorbed, and by the time the embryo is mature the endosperm also has entirely disappeared.

THE ENDOSPERM

The division of the primary endosperm nucleus as a rule precedes that of the fertilized egg (FIG. 17), although one preparation showed the egg nucleus and the primary endosperm nucleus dividing simultaneously. In *Phaseolus multiflorus*, Guignard (1881) found that the division of the egg nucleus and that of the primary endosperm nucleus occur at the same time; Strasburger (1880) observed the simultaneous division of these two nuclei in *Lupinus;* but Martin (1914) found that the first division of the fertilized egg is usually preceded by the first division of the primary endosperm nucleus.

The endosperm nuclei resulting from the first two divisions arrange themselves in the periphery of the embryo-sac. Usually two of them are to be seen near the young embryo, one on either side of it. The later nuclear divisions are not always simulta-

neous, for in several instances both resting nuclei and nuclei in the various stages of division are to be seen distributed from one end of the sac to the other (FIG. 28); but the order of their arrangement was not identical in the different sacs observed.

The endosperm remains in the form of a peripheral layer in the embryo-sac until its final absorption by the growing embryo; it is typically thicker around the embryo than in other regions of the sac. After the differentiation of the dermatogen, cell division occurs in that part of the endosperm which immediately surrounds the embryo itself. Each nucleus in this part of the endosperm is surrounded by a very definite cell wall; the cells so formed, however, do not form a compact mass but lie isolated in the undivided cytoplasm (FIG. 29). These cells do not persist but are soon absorbed, and all traces of the endosperm have entirely disappeared by the time of the maturity of the seed.

SUMMARY

1. A large hypodermal cell is early differentiated in the ovule; this either functions as the macrospore mother cell or possibly divides once, one of its daughter cells being the macrospore mother cell.

2. The fully grown macrospore mother cell lies in either the third or fourth layer from the micropylar end of the nucellus.

3. An axial row of three macrospores is formed, the innermost of which develops into the embryo-sac.

4. The nucellus is entirely destroyed at the micropylar end and along the sides by the development of the embryo-sac; the nucellar tissue at the base of the sac takes on a peculiar structure and persists for some time, but finally is itself gradually absorbed by the embryo-sac.

5. The polar nuclei begin to approach each other soon after the eight-nucleate stage of the embryo-sac is reached and remain close together for some time just below the egg; then their fusion takes place.

6. The three antipodal cells disappear at about the time of fertilization.

7. The synergids form a conspicuous filiform apparatus.

8. The pro-embryo consists of a filament of three cells; the

two basal cells form the suspensor and the terminal cell develops into the embryo proper.

9. The dermatogen is cut off when the embryo proper consists of about sixteen cells. When the suspensor consists of four rows of about seven or eight cells each, the two tiers of cells at its base become swollen and conspicuously elongated.

10. The primary endosperm nucleus usually divides before the first division of the egg; two of the daughter nuclei resulting from the first two divisions place themselves on either side of the young embryo; and in succeeding divisions the endosperm nuclei place themselves in the peripheral region of the embryo-sac.

11. The divisions of the endosperm nuclei may be simultaneous, or nuclei in all stages of division may be found at the same time, from resting nuclei at one end of the endosperm to late telophases at the opposite end.

12. Endosperm cells are formed in the region immediately about the embryo, but are later absorbed.

I wish to express my sincere appreciation to Dr. C. E. Allen, who suggested this work and under whose supervision it was done.

UNIVERSITY OF WISCONSIN

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Explanation of plates 25 and 26

All drawings were made with an Abbé camera lucida at table level. Leitz oculars and objectives were used: FIGS. 1, 2, 6–10, 14–20, 22, with ocular 4, oil immersion objective 1/16, tube length 222 mm. (× 2,475); FIGS. 4, 5, 11–13, 21, 23, 25, with ocular 4, oil immersion objective 1/16, tube length 170 mm. (× 1,740); FIGS. 24, 26, 28, with ocular 3, oil immersion objective 1/16, tube length 170 mm. (× 1,530); FIG. 3, with ocular 1, oil immersion objective 1/16, tube length 140 mm. (× 966); FIG. 27, with ocular 3, objective 3, tube length 170 mm. (× 170); FIG. 29, with ocular 3, oil immersion objective 1/16, tube length 140 mm. (× 570). The drawings on PLATE 25 have been reduced one half in reproduction; those on PLATE 26, two thirds.

PLATE 25

FIG. 1. Young nucellus showing enlarged hypodermal cell.

FIG. 2. Young macrospore mother cell.

FIG. 3. Nucellus showing two macrospore mother cells in an axial row.

FIG. 4. Nucellus showing the position of the young macrospore mother cell represented on a larger scale in FIG. 2.

FIG. 5. Nucellus showing two layers of cells between the epidermal layer and the macrospore mother cell.

FIG. 6. Fully grown macrospore mother cell.

FIG. 7. Macrospore mother cell with nucleus in synapsis.

FIG. 8. Macrospore mother cell with nucleus in division.

FIG. 9. Row of three macrospores; the two upper ones are degenerating, the third has enlarged and will develop into the embryo-sac.

FIG. 10. Mature egg.

PLATE 26

FIG. 11. Functional macrospore with the two degenerating macrospores lying above it in the nucellus.

FIG. 12. Binucleate embryo-sac.

FIG. 13. A four-nucleate embryo-sac.

FIG. 14. A mature embryo-sac.

FIG. 15. Egg and synergids showing filiform apparatus.

FIG. 16. Polar nuclei fusing.

FIG. 17. An egg and two endosperm nuclei.

FIG. 18. A two-celled pro-embryo.

FIG. 19. The second division in the pro-embryo.

FIG. 20. A three-celled pro-embryo.

FIG. 21. The terminal cell of the pro-embryo has divided longitudinally.

FIG. 22. An embryo consisting of six cells.

FIG. 23. An embryo after further transverse divisions have occurred; the basal cells are enlarging.

FIG. 24. An embryo showing anticlinal walls in the terminal cells.

FIG. 25. Periclinal walls in the embryo proper.

FIG. 26. An older embryo showing suspensor with no distinct demarcation between it and the embryo proper.

FIG. 27. Embryo showing cotyledon, hypocotyl, and epicotyl. The basal cells are compressed against the integument.

FIG. 28. Endosperm nuclei dividing.

FIG. 29. Endosperm cells formed in the region of the embryo.

Hawaiian trees—a criticism

JOSEPH F. ROCK

In the March number of the *Bulletin of the Torrey Botanical Club* for 1917 (44: 145–157), there appeared a paper by Vaughan MacCaughey, entitled "An annotated list of the forest trees of the Hawaiian Archipelago." The paper, which the author describes as the first "comprehensive and concise check list" of the Hawaiian forest trees, is by no means exhaustive. The nomenclature has apparently been copied in its entirety from my book on the indigenous trees of the Hawaiian Islands, published in 1913, and certain more recent articles on critical families, in which species from the islands are described, are not considered.

That the author's knowledge of Hawaiian plants is incomplete is evidenced by his remarks under *Pritchardia*, where he states, "there are at least two well-defined species, *P. Gaudichaudii* H. Wendl. and *P. Martii* H. Wendl." These two species are not at all well defined. Their types, in fact, which Dr. Beccari and I have examined in the Webb herbarium at Florence, Italy, consist of immature leaf specimens only, and their published descriptions are extremely meager. Neither of the two species has been collected again in a wild state since its original discovery, and of *P. Gaudichaudii* no cultivated specimens are extant. It was supposed to have been found on a rock islet off the windward coast of Molokai, not far from the leper colony. Nine other species of *Pritchardia*, however, are now known from the Hawaiian Islands. These species are all well defined and are all represented by complete living and herbarium material. An extensive publication by Beccari,* in which full descriptions may be found, seems to be unknown to the author.

Besides the works dealing with *Pritchardia*, there are several other instances of unfamiliarity with the recent literature which might be cited. Heimerl's paper on certain genera of the Nyctag-

* Contributo alla conoscenza delle Palme. Webbia 4: 143–240. *f. 1–17.* 1913. See also Rock, J. F., A new species of *Pritchardia*. Bull. Torrey Club, 43: 385–387. *pl. 21 + f. 1.* 1916.

inaceae* is a case in point. In this work the Hawaiian representatives of the family are completely revised, and the genus *Pisonia*, of which MacCaughey lists three species, is no longer recognized as occurring in the Hawaiian Archipelago, one species being made the type of the new genus *Rockia* and the other two being transferred to the genus *Calpidia*. Martelli's publications on the Pandanaceae,† in which species from the Hawaiian Islands are described, Loesener's work on the Aquifoliaceae,‡ in which the synonymy of the Hawaiian species of *Ilex* is revised, and my own paper on the Santalaceae§ are also completely ignored.

To my mind a check list is of doubtful value unless brought up to date. The copying and publishing of names without proper revision and study is certainly not desirable.

COLLEGE OF HAWAII,
HONOLULU

* Die Nytaginaceen-Gattungen *Calpidia* und *Rockia*. Oesterr. Bot. Zeitschr. **63**: 279–290. 1913.

† Enumerazione delle Pandanaceae. Webbia **3**: 307–327. 1910; **4**: 1–105. *pl. 1–17*. 1913. Le specie e varietà nuove di "*Pandanus*" menzionate nella enumerazione delle Pandanaceae. Ibid. **4**: 399–435. *pl. 18–43*. 1914.

‡ Monografia Aquifoliacearum—I. Nova Acta Acad. Leop.-Carol. **78**. 1901.

§ The sandalwoods of Hawaii. A revision of the Hawaiian species of the genus *Santalum*. Hawaii Board Agr. & Forest. Bot. Bull. **3**: 1–43. *pl. 1–13*. 1916.

The botanical work of Ezra Michener

C. L. Shear and Neil E. Stevens

The reputation of a botanist depends so largely on publication that important work of collecting and collaboration may be very soon forgotten. This has been too nearly true of the botanical work of Dr. Ezra Michener. Almost all of his long life (1794–1887) was spent in a small village in the southern portion of Chester County, Pennsylvania, "almost entirely isolated," as he says, "from the seats of learning, from scientific libraries, and from personal intercourse with the cultivators of science" (**8**, p. iii). In addition to the numerous duties of a country physician and of a prominent citizen interested in reform movements he accumulated a valuable herbarium, contributed to Darlington's Flora Cestrica, published a "Manual of Weeds" (**7**) for popular use, rearranged and mounted the extensive Schweinitz collections of fungi in the Academy of Natural Sciences of Philadelphia, and carried on a correspondence and exchange of specimens with the leading mycologists of his time.

Michener himself seems to have regarded his botanical work as of little importance. In his "Autographical Notes" (**8**), a volume of two hundred pages, in which he gives the main facts of his life and interests, he speaks of his "innate fondness for plants" and describes his early progress in the study of botany. Later references to botanical work are largely incidental, as when he describes a botanical press which he devised (p. 43), or speaks of rearranging his herbarium of more than a thousand plants during an illness which occurred in 1843 (p. 52), or of collecting plants while on a trip to Virginia in 1846 (p. 59). He refers, however, to assisting Dr. Darlington in the preparation of the Florula Cestrica (p. 43). The above facts are summarized by Harshberger (**5**) in his "Botanists of Philadelphia." A brief biological note, reprinted from the West Chester Republican, was also published in the Friends' Intelligencer and Journal, July 2, 1887 (**9**).

A few years ago the writers discovered that Michener mounted the fungi in the Schweinitz herbarium in Philadelphia (**11**, p. 7), and while continuing their investigations on this important herbarium were able to determine the date of this work (**10**). In trying to determine this latter point the writers made a thorough search in the region about Dr. Michener's home near Toughkenamon, Pennsylvania, for documents which might throw light on the matter.

CORRESPONDENCE WITH CURTIS AND OTHER BOTANISTS

Dr. Michener's correspondence, which is known to have been voluminous and to have contained letters from some of the most eminent scientists of his time, including Curtis, Ravenel, and Tuckerman (see Harshberger **5**, p. 180), appears to have been destroyed. No portion of it could be found either at his former residence, now occupied by his grandson, Ezra J. Webster, or elsewhere. Fortunately, however, Miss Alice Swayne, librarian of the Bayard Taylor Memorial Library, Kennett Square, Pennsylvania, who had previously assisted the writers and was aware of their interest in the Michener correspondence, found a few pages of letter press copies of letters from him in his collection of shells now in the possession of the library. Although there are but twelve sheets of this letter press, numbered consecutively 2 to 13, several of which are somewhat worn, some of the letters from Dr. Michener contain information of great value. That such fragmentary records accidentally preserved must be depended on for information concerning a botanist who died only thirty years ago, argues a neglect in the preservation of accurate historical records which is most unfortunate.

Two letters to Curtis, copies of which were found in the letter press referred to, throw so much light on Michener's purpose and methods in taking up the study of fungi, as well as on his personal relations with Curtis that they are here included nearly in full.

[6]* NEW GARDEN 26th of 11th mo 1855

Dear Friend:

It seems a long time since I have written to thee. Thy note of Sept 11th came duly to hand, requesting to have some of *Botrytis infestans* and would have been

* Figures refer to pages of the letter press.

promptly responded to if I could have found the thing.—Unfortunately the potato tops were gone before it arrived—and I waited to know whether any could still be found—since which time I have been much from home and mostly occupied with other cases.—An unusually wet season ha[s] produced an abundant growth of our favorite plants—the Fungi—of which a large number hav[e] been collected—but from the tone of thy last note (without date) I feel compelled however reluctantly to decline transmitting them at present.

The inducements which led me into the study of the fungi are a desire to supply a blank in the catalogue of Natural productions of Chester County, which some of us contemplated—and while I could not obtain the means to determine all the species myself—I vainly hoped that my services as a collector of fungi, might entitle me to the assistance which I stood in need of in determining species.—Disappointed in this hope, I have but little inducement to prosecute the study much farther—yet there is a charm attending it which will probably [con]tinue as long as I am able to pursue it.—How is the review of Schweinitz progressing? I have been watching for it in the Journal of the Academy. In a few days I expect to commence arranging Schweinitz Fungi—and it would have been a great pleasure to have [7] had the assistance of your corrections during the examination of his species.—I shall however implicitly follow his numbering and labeling [two words blurred] out in the Synopsis Fungorum.—

Enclosed will be found specimens of a few of my back numbers which were marked as desiderata:—

As heretofore
thy friend

M. A. CURTIS— E. MICHENER

N. B.—Please write whenever convenient.—

Curtis's reply to this letter may be readily guessed at from another letter which Michener wrote several weeks later. This letter, which is without address, shows from the context that it was written to Curtis.

[12] NEW GARDEN 28th of 1st mo 1856.

Dear friend,

Thine of the 8th instant was duly received.

It was a kno[w]lidge of thy numerous engagements in the Mycological field—apart from "business" proper, which has frequently led me to feel and to express a fear of trespassing too much upon thy time—and, so far as I can recollect, has prevented me from making any claim upon thy attention farther than it may have been convenient to thee to bestow—nor am I conscious of having manifested that "impatience" of which thee speak.—Be this as it may—thy last preceding note commenced by saying—"You need not trouble yourself by sending me specimens too often." This was language which I thought could hardly be misunderstood, and my consequent course has been taken according to my acceptance of it.—In future I will send remittances (as in truth I have always done) in strict conformity with the conditions laid down in the note referred to. vis.—"You are at liberty to [se]nd as often as you please, only leaving the liberty to answer whe[n] I please."

[The next paragraph, of four lines, is somewhat blurred and is here omitted.]

In working over the first eight books of Schweinitz' Fungi, I have been grieved to find a number of the envelopes either missing or empty in addition to the many which rendered valuless by the ravages of insects.—Perhaps the destruction will not be so great after we get through the Hymenomycetes.—

Ever thine with respect,

E. MICHENER.

Four other letters of which letter press copies are preserved deal with Michener's botanical interests. In two letters to E. Lanning he speaks of exchanging specimens, including fungi, and of having received a parcel of fungi from "our friend H. W. Ravenel." In a letter dated "New Garden, 28 of 11 mo., 1855," to Dr. William Darlington, who had apparently referred to Michener some question of fungus identity, he quotes a considerable portion of Fries description of *Penicillium crustaceum* from Fries Systema Mycologicum (**3**: p. 407, 408), indicating his familiarity with this standard mycological work. In a letter to Mr. Thomas P. James, dated "New Garden, 4th of 1st mo., 1856," he requests the loan of another lens—"I greatly feel the want of another glass. . . . The powers which [I] have are 20, 30, 50 and 250, one intermediate between the two last, say from 80 to 150 would often assist me wondrously."

In writing to Curtis of the proposed "Catalogue of Natural Productions of Chester County" Michener evidently had reference to the work of the Chester County Cabinet, an organization formed under the leadership of Dr. Darlington, the object of which was "two-fold: first, to form a collection of the natural productions of the County; and second, to gather materials for its prospective history" (**8**, p. 43). Michener evidently undertook the compilation of a list of fungi (**6**, introduction; **2**, p. iv; and **4**, p. 458). To this end he corresponded and exchanged specimens with Ravenel and Curtis, especially the latter, until, as he wrote at the age of eighty-five (**4**),

"There have been some 1200 species of fungi collected and preserved in this county, a very large percentage of which have passed under the experienced eyes of Berkeley and Curtis, and carry the impress of their determination, it is impossible for me, at this late period of life, to arrange them properly in a catalogue without more efficient aid than I am able to obtain."

OTHER INTERESTS

Michener naturally included the lichens in his studies and sent numerous specimens to Tuckerman for identification (see **12**). That he was a collector of no mean ability is shown by the fact that in his list of lichens of Chester County, published in the third edition of Darlington's Flora Cestrica, 1853, there are included (**3**, p. 456) "about 20 species never before published in this country, one-half of which are entirely new." These new species are all described by Tuckerman, who named one species *Biatora Micheneri*, in Michener's honor. Tuckerman also named a species in this list in honor of the county, *Verrucaria cestrensis*. Tuckerman presented Michener with a complete set of his "Lichenes Americae Septentrionalis," inscribed

"Dno. E. MICHENER,
AUCTOR
10 AUG. 1852."

These volumes, which bear notes in Michener's hand, are now in the possession of the writers.

Darlington's impression of Michener is frankly stated in the introduction to this edition of the Flora Cestrica, in which he refers to him as "a naturalist from whose acumen, diligence, and indomitable perseverance we may fairly expect as thorough an exploration of every department of our Cryptogamy, as the active duties of his profession and the life-time of an Individual will permit."

Michener's interest in natural science was by no means confined to botany. He was co-author with Dr. William D. Hartman of a work on the shells of Chester County, and prepared a considerable portion of the section on "Zoology" in the history of Chester County compiled by Futhey and Cope (**4**). In this there are numerous footnotes signed with his initials, indicating close field observations on the habits of birds.

In the manuscript "Catalogue of the Museum presented to Swarthmore" are listed with Michener's usual care four hundred and twenty-six species of mammals, birds, and reptiles, arranged in accordance with the nomenclature of the best authorities of his time. The greater portion of these specimens (**8**, p. 202) had

been mounted by Michener himself. The manuscript has been deposited in the library of the Department of Agriculture.

Michener was also interested in genealogy and contributed a history of his family to the history of Chester County just mentioned. There is in the possession of his grandson, Mr. Ezra J. Webster, of Toughkenamon, Pennsylvania, an elaborate genealogical study of the Michener family, prepared by Dr. Michener.

THE MANUAL OF WEEDS

In 1872 Michener published a volume of about one hundred and fifty pages, entitled "A Manual of Weeds or the Weed Exterminator," designed, as he says in his introduction, to supplement Darlington's (2) Agricultural Botany, and "to place in the hands of the young and intelligent culturist * * * a cheap, and reliable Hand book of Weeds." This book does not seem to have received wide circulation. There is no copy in the Library of Congress or in the Library of the Department of Agriculture. A copy in the Bayard Taylor Library at Kennett Square, Pennsylvania, was, however, loaned to the writers by the librarian, Miss Alice W. Swayne.

The manual lists one hundred weeds systematically arranged, many of them with observations as to habit of growth and suggestions for their control. There is also a glossary of botanic terms.

In the introduction, which fills twenty pages, Michener exhibits considerable grasp of the fundamentals of plant physiology. He refers to the leaves as "the essential organs of digestion, assimilation, and respiration." That he understood many of the principles of plant distribution is evidenced by his warning against the practice of throwing weed seeds into water courses, and to the danger of carrying rhizomes from field to field on agricultural implements. He refers to the blackberry as a bi-per-annual because, as he says, "the root is per-annual and the stem strictly bi-annual." A characteristic remark is that "field fence corners cannot appropriately be used for flower gardens."

Some of his ideas as to the control of weeds must have seemed rather radical fifty years ago. For instance, he urges that the weed question is not a matter merely "of individual, of local, or of agricultural interest. It is more than all this. . . . It is

national in all its bearings." Then drawing an analogy from the city boards of health and their quarantine laws, he urges "the establishment of an agricultural board of health in every district, invested with ample powers and resources to maintain a healthy agriculture," and adds: "It may be necessary to provide *inspection of seeds* before they are allowed to be sowed." These suggestions are in part carried out at the present time by our Federal Horticultural Board and by state seed inspection laws. It is possible that we may in time arrive at the condition finally urged by Michener, who suggests that in case a farmer does not properly care for his fields "it may be necessary to remove him temporarily from his premises, and to place them in the hands of an agent until they are fully cleansed from the infection."

PHILADELPHIA ACADEMY OF SCIENCES

Michener was elected a correspondent of the Academy of Natural Sciences, Philadelphia, in 1840, and throughout his life it formed his chief contact with the scientific world. While Michener's name appears but rarely in the records, his services to the Academy were considerable and his interest great.

The writers have already called attention to the fact that the mounted portion of Schweinitz's collection of fungi at the Philadelphia Academy is mounted in exactly the same manner as are the specimens in Dr. Michener's herbarium (11). It is now evident that the method of arrangement was original with Dr. Michener. For in the files of the Academy is the following letter written on the outer surface of a brown paper folder indentical in size and kind of paper with those in the Michener herbarium, and having pinned on the inner side three of the small square sheets of ruled paper like those on which the fungi are pasted in his herbarium (11, *pl. 3, 4*). This sheet was evidently intended as a sample, and Michener thriftily utilized the outside of the sample for his letter.

Erysiphe Hed fil: (Evidently not a part of the letter but of the sample, i. e., it is the label.)

AVONDALE 26th of 11th mo 1855.

Dear Doctor,

I have inclosed a sheet of my paper with a specimen of labels, such as I use, for thy examination.—From which thee will vary the size of the sheet; and the size

and number of the labels, to each sheet—as thy own judgment may direct.—Common Bookbinders boards are not substantial enough for the portfolios—they should be very firm.—

A stouter paper than this sheet would also be better for the first class (Hymenomycetes) as many of the species are very course and rugged . . .

Should we succeed satisfactorily with the Fungi—perhaps we may then be prepared to arrange the Lichens & Musci in the same way—but will try one at a time.

If the portfolios should not be sent with the other materials please inform me what size the Boards for them will be cut.

Respectfully

E. MICHENER

DR. ZANTZINGER.—

The first package of fungi appears to have been sent to Dr. Michener shortly after this letter was written for early in the following year, 1856, he sent a letter to the Academy concerning the problems connected with their rearrangement. This letter contains so much information regarding the condition of the herbarium at that time as well as the part played by Michener in its rearrangement that it is here printed in full.

NEW GARDEN 16 of 1 mo 1856

Botanical Com. Acad. Nat. Sciences,

I have mounted specimens of all that could be found in the parcel of Fungi sent. Many however were totally destroyed by insects—or had otherwise disappeared.—The envelopes very rarely contain more than two, quite common only one specimen—That I have felt a constant fear of being suspected for the same proclivity which characterize some other would-be naturalists. As a *preventive* I would suggest that you carefully look over the collection before sending it so as fully to appreciate its dilapidated condition.

There are two points upon which I wish the advice of the com.—If the port folios are not yet made I would suggest the propriety of reducing the size of the sheets and labels.—I am not unmindful of a desire to preserve uniformity in the entire Herbarium (and this could still be done in appearance on the shelves) but I think it would be at the cost of convenience and utility.—If it does not come too late I would recommend the size and form of the accompanying specimen—The adoption of it would cost you a trifle of lost labour—and me a good deal more but I think would repay it.—

I also wish your advice upon the arrangement—The original idea was to follow Schweinitz Synopsis so far as specimens were to be found—and then to fill up the blanks so far as I can out of my own collection.—But this does not admit of introducing either his own exotic species—or other more recent discoveries in their proper connection.—We have no very good classification but must follow some one—I prefer Lindley's [revised ?].—The specimen sheet is intended to discriminate between the North American & exotic species of Shw. Herb.—and also those which may be subsequently added—by the colour of the paper a reference on the label to the source whence the specimen was derived. If this should be thought sufficiently to

designate the specimens you will perceive that additions can at any time be made [reverse of sheet] without interference with the previous labour.—

Should you approve the plan paper could be selected of such size as would cut without much waste.

Please advise me early of your conclusion in the matter.

Yours respectfully

E. MICHENER

N. B.—I can not return the package until I receive the portfolios to place them in. —What would you want done with the old books, envelopes, etc.?—a few of them contain specimens which ought to be preserved—and it might be worth while to retain Sch. own labels along with the specimens—but this would open a wider field for labour.—

E. M.

Evidently, the committee did not agree with Michener that the size of the sheets should be reduced, for the mounted portion of the Schweinitz herbarium at Philadelphia is on sheets of folio size, whereas those in Michener's own herbarium are quarto. Very fortunately, however, his suggestion that the original packets were worth retaining was accepted, as these are now preserved in the Academy.

Michener worked on this herbarium during the winters of 1855–56 and 1856–57, and in 1857 sent to the Academy a considerable collection of fungi, as indicated by the report of "Donations to Museum" in the Proceedings for that year:

Seven hundred and ninety-six species fungi (finely mounted specimens). Presented by Rev. M. A. Curtis. Two hundred and one species fungi (finely mounted specimens). Presented by Ezra Michener, who prepared all the specimens.

The files of the Academy of Natural Sciences in Philadelphia contain five letters from Michener regarding the rearrangement of the Schweinitz herbarium and in the interval after that only three brief notes. Dr. Nolan, Secretary of the Academy, states that while the files are by no means complete, it is very probable that these are all the communications received from Michener, as he was characteristically a man of few words. Two letters written in 1867 referred to copies of the Proceedings of the Society which he had found missing when the volumes were being sent to the bindery. The remaining note written on a half sheet of letter paper is from its date and nature probably the last communication of Dr. Michener to the Philadelphia Academy.

TOUGHKENAMON 6 of 3 mo. 1882

EDW. J. NOLAN, M. D.

Dear Friend

Please find enclosed a postal order ($5) for my subscription for the Proceedings of the Acad. Nat. Sc. —

I have taken them for more than forty years, with interest, but the lapse of 88 years wear and tear, has disqualified me for such reading and studies.

Please close my subscription at the end of the current volume.

And oblige

Thine sincerely

E. MICHENER.

THE MICHENER HERBARIUM

Dr. Michener's zoological collections, as stated in a brief supplementary note published with his autobiography, which were given to Swarthmore College in 1869, were there lost in the fire which occurred a few years later. Very fortunately, however, his herbarium as well as a collection of shells remained in the possession of his children. The preservation of the herbarium seems to have been largely due to the interest of his son, Ellwood Michener, who apparently inherited his father's taste for botanical studies and accumulated an herbarium of flowering plants which the writers have examined.

Some years before his death, Ellwood Michener presented the collections of plants and shells to the Bayard Taylor Memorial Library, of Kennett Square, where they remained until 1917. The trustees of the library, however, realizing that the herbarium would be more accessible to scientific investigators as well as more carefully preserved in the Department of Agriculture, sold the collections of fungi to the mycological collections of the Bureau of Plant Industry.

In addition to portions of many of Schweinitz's specimens, as described in an earlier paper (**11**, pp. 7–11), the Michener herbarium contains numerous specimens from the collections of fungi described by Berkeley and Curtis (1) as well as fungi identified by Michener himself. With the exactness characteristic of all his work Michener indicated on the labels the source of the specimen and by whom it was identified. This collection of fungi which has now been made available for study will prove of great value to American mycologists. The herbarium also contains an excel-

lent collection of lichens, with many authentic specimens from Tuckerman, who identified most of the material. There are also many phanerogams, a good collection of mosses, many of which are from Europe, and a few hepatics and algae.

Although Michener published very little, his contributions to botany were considerable. Realizing the limitations of his own situation and the impossibility of satisfactorily identifying all the species himself he wisely sent his collections for identification to the leading authorities on the several groups, and devoted his own energies to collecting and preparing his herbarium. He thus secured an authoritative and fairly comprehensive flora of his region, and added to the number of known species and to the known distribution of species already recognized, a type of botanical work greatly needed.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1915-1917

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Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

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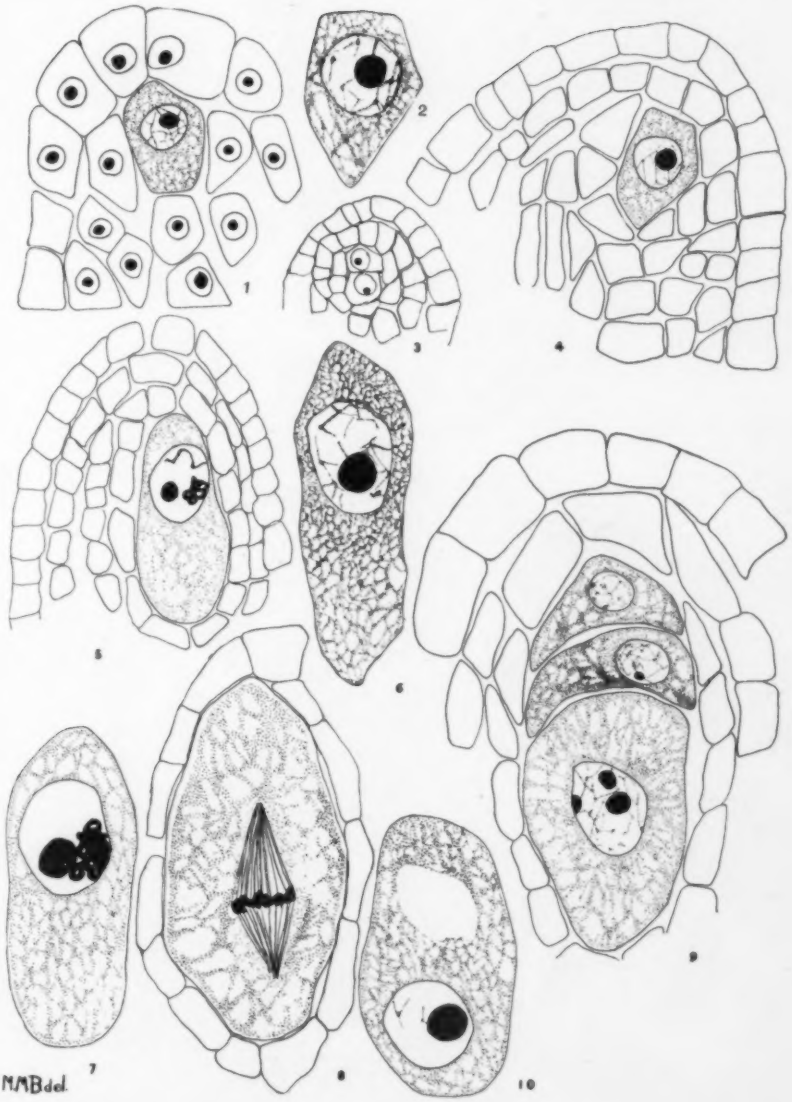

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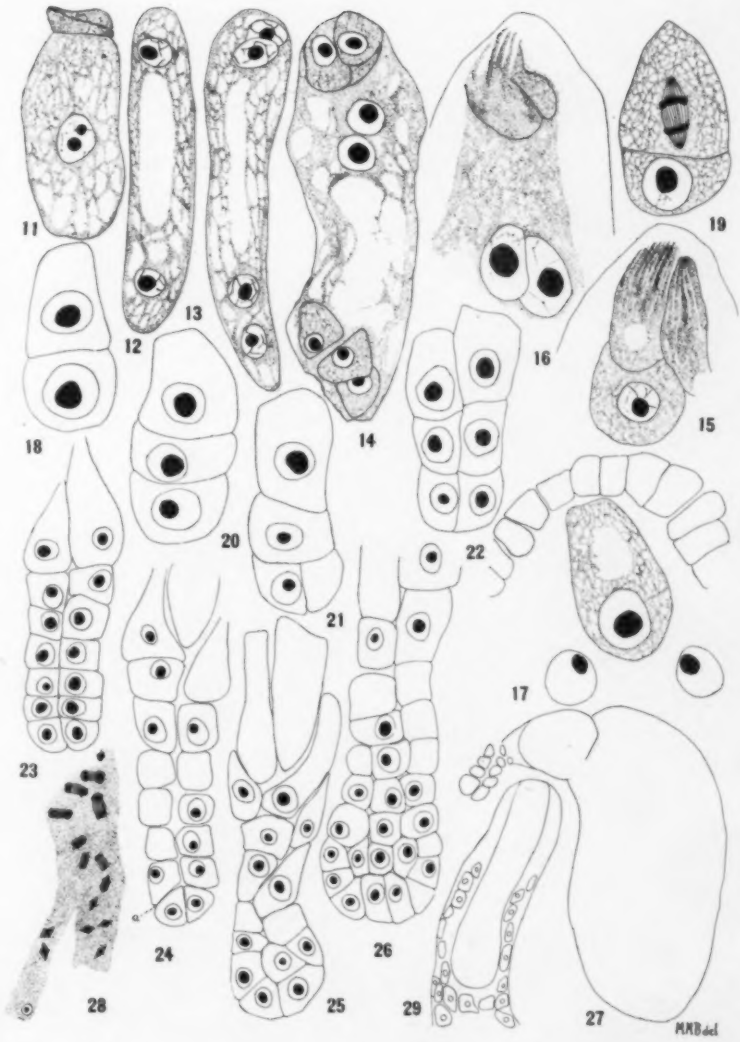

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